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THE APPLE-SNAILS OF SIAM.

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WITH 2 PLATES.

The Ampullariidae or Apple-Snails are the largest of the freshwater Gastropod molluscs and can as a rule be recognized by their comparatively great size and by their almost globular shells. Even the smaller forms are considerably larger than most other water-snails, but a few gigantic Pond-Snails (Viviparidae), found mostly in China, are larger than the smallest species, and approach the Ampullariidae in shape of shell. The Oriental Apple-Snails can, however, be readily distinguished from all others of large or moderate size found with them by their thick shelly opercula, and by the fact that they possess, in addition to the ordinary tentacles, a tentacle-like process on either side of the mouth. They are found in ponds, marshes, rice-fields and sluggish streams, where aquatic vegetation grows luxuriantly, for they are voracious feeders and their chief food consists of water-plants, which they masticate by means of a pair of stout horny jaws, situated laterally, as well as scraping them with the teeth of their lingual ribbon, which are unusually large. On occasion they will eat decaying animal matter, including the bodies of their own kind, and some species rasp small algae from the shells of their fellows, causing unsightly patches as they remove the epidermis or periostracum with the algae.

The breathing apparatus of these snails is of complex structure and the branchial chamber is divided into two parts, one of which may be described as a lung for breathing air, while the other is a cavity in which it is supposed that oxygen can be extracted from water. They are, however, practically air-breathers, and may be observed to rise to the surface from time to time and thrust out through the surface-film a stout funnel-shaped siphon, through which they draw air into their lung.

In countries that have a dry and a wet season, the Ampullariidae aestivate or hibernate in the former, burying themselves in the ground, where they remain in a comatose condition, with the operculum tightly closing the shell, until rain falls.

The shell does not increase in size while the animal is inactive; indeed, growth seems to be limited to the early part of the active season. A growing shell can usually be recognized by the extreme thinness of the free margin of its mouth.

The eggs are large and have a brittle, white, calcareous shell. Some species lay them in irregular masses in depressions in the ground, while others attach them to the tree-trunks, posts, etc., at the edge of water. In the former case the eggs are spherical and adhere together lightly, in the latter they may be so closely compacted as to be irregular in form. In one Siamese species (*Pachylabra turbinis*) only the inner eggs of the mass are fertile, the outer eggs being degenerate and forming a protective covering for the fertile ones.

Only one genus is at present recognized among the Oriental Ampullariidae, but it will probably be necessary to separate a small Indian species (*Ampullaria nux* Reeve) on anatomical grounds. This species differs from its present congeners in living in small mountain torrents. There has been much dispute within the last few years as to the generic, and hence the family, name of the ordinary species. Until recently all those forms the shell of which has a right-handed spiral were known as *Ampullaria* Lamarck (1799), and the family as Ampullariidae; the genus was believed to be of circumtropical range. But there can be no doubt (1) that the type-species of *Ampullaria* was (though Lamarck was

ignorant of the fact) a West Indian form, and (2) that the Neotropical species differ from those of Africa and Asia in having a horny instead of a calcareous operculum, and in the fact that the siphon when expanded is an elongate cylindrical tube many times as long as thick, whereas that of the Oriental and African species is in the same condition no longer than broad and distinctly funnel-shaped. These characters seem to be of generic importance.

Granting that these species are generically distinct from the American ones, and that the name *Ampullaria* properly belongs to the latter, recent writers adopt one of two generic names for the African and Oriental species, either *Pila* Bolton (1798) or *Pachylabra* Swainson (1840). *Pila*, as Kobelt¹ has shown, is inadmissible and I have, therefore, adopted the name *Pachylabra*. This course leaves the family name Ampullariidae intact.

In describing the Siamese species of *Pachylabra* I have had in my hands material from the following sources:—

- (1) The old collection of the Indian Museum, discussed in Nevill's "Hand List" (1884).
- (2) A fine series of shells of *P. turbinis* var. *dalyi* from Pitsanuloke presented to the Indian Museum some years ago by Mr. H. W. Biggie of the Indian Forest Service.
- (3) A small collection made by myself in the province of Singgora (Songkla) in 1916.
- (4) Another recently made by Mr. C. Boden Kloss in the Korat district and on Koh Samesan in the Gulf of Siam, and presented to the Indian Museum by him.
- (5) A series of shells and living specimens of the new species *P. angelica* sent me from Bangkok by Dr. Malcolm Smith in July, 1919.

I have to thank those who have provided much of this valuable material, and also Dr. Bains Prashad of the Bengal Fishery Department, who has sketched the radulae figured in this paper

¹ Kobelt, Fam. *Ampullariidae* in Martini and Chemnitz's *Conch.-Cab.*, p. 44 (1911). See also Dall, *Journ. Conch.* (London) II. p. 50 (1904).

and has given me other assistance. The drawings and photographs, here reproduced, have been prepared by the artists of the Zoological Survey of India.

The Zoological Survey of India would be very grateful for further specimens from any part of Siam, as they would be of great assistance in the survey of the freshwater molluscs of the Indian Empire that we are at present undertaking. Living snails will travel safely in a dry condition to Calcutta by post, as those sent me by Dr. Malcolm Smith have proved.

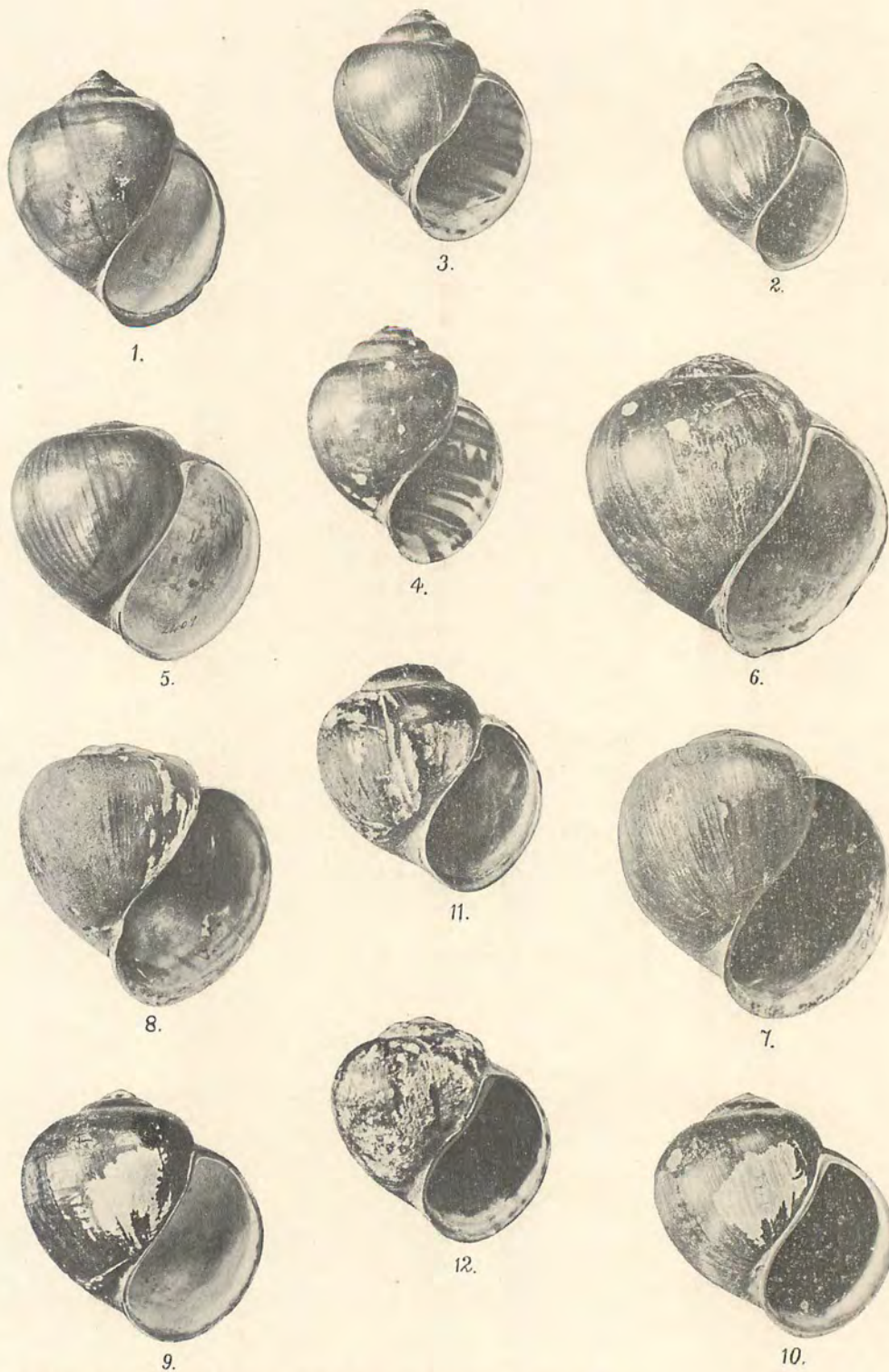
Pachylabra Swainson.

1911. *Pachylabra*, Kobelt, Fam. *Ampullariidae* in Martini and Chemnitz's *Conch. Cab.*, p. 44.

In this genus are included all the normally right-handed species of *Ampullariidae* that have a calcareous operculum. It is necessary to insert the word "normally", because in certain species (*e. g.* the common Indian *P. globosa*) abnormal shells occur (very rarely) that have a left-handed spiral. Information is not available as to the anatomy of such aberrant individuals, but in the African genus *Meladomus*, in which a left-handed spiral is a normal generic character, the shell is said to be hyperstrophic and the anatomy of the animal is not reversed.

The range of the genus is strictly tropical. In India it does not extend into the Punjab, though it embraces the whole of the plains of the Gangetic system and the greater part of South India. Generally speaking it may be defined as consisting of the Ethiopian and Oriental Regions, including Madagascar, with the exception of desert and mountainous areas. In Siam at least seven species are found. In "Etudes diverses" of the Mission Pavie to Indo-China (Vol III, 1904, p. 425) Fischer and Dautzenberg give the following particulars of species recorded from Siam:—

<i>P. borneensis</i> (Philippi)	from Bangkok & Chengmai
? <i>P. celebensis</i> (Quoy & Gaimard)	„ "Siam"
? <i>P. conica</i> (Gray)	„ "
<i>P. globosa</i> (Swainson)	„ (The marshes of the Menam near Bangkok).



DESCRIPTION OF PLATE I.

Pachylabra polita (Deshayes).

- Fig. 1. Large shell from Cambodia. Half natural size.
Fig. 2. Type—specimen of var. *compressus* Nevill, from Cambodia. Half natural size.

Pachylabra conica (Gray).

- Fig. 3. Shell from Pegu, Burma. Two-thirds natural size.

Pachylabra gracilis (Lea).

- Fig. 4. Shell from Siam. Natural size.

Pachylabra turbinis (Lea).

- Fig. 5. Type-specimen of var. *subglobosa*, Nevill. (From Siam. Half natural size.

Pachylabra turbinis var. *dalyi* (Blanford).

- Fig. 6. Large shell from Pitsanuloke, Siam. Half natural size.

Pachylabra turbinis var. *subampullacea*, Nevill.

- Fig. 7. Large shell from Lampam, Patalung, Siam. Half natural size.

Pachylabra turbinis var. *lacustris*, nov.

- Fig. 8. Type-specimen from the Tale Sap, near Lampam, Siam. Half natural size.

Pachylabra angelica, sp. nov.

- Figs. 9, 10. Type-specimens from Bangkok. Half natural size.

Pachylabra begini (Morlet.)

- Fig. 11. Shell from Korat district. Two-thirds natural size.

Pachylabra pesmei (Morlet).

- Fig. 12. Shell from Koh Samesan off C. Liant, Gulf of Siam. Natural size.

<i>P. gracilis</i> (Lea)	from "Siam"
<i>P. pesmei</i> (Morlet)	„ Srakao
<i>P. polita</i> (Deshayes)	„ Chengmai
<i>P. turbinis</i> (Lea)	„ "Siam"

The occurrence of *P. borneensis* [the synonymy of which is still doubtful], of *P. celebensis* [= *P. ampullacea* (L.)] and of *P. globosa* in Siam is most improbable. The two former are species found in the Malay Archipelago and are known to have been often confused with mainland forms. *P. globosa* is the common form in the valley of the Ganges. The species here described as *P. angelica* may have been confused with it.

The late Dr. W. T. Blanford, who was well acquainted with the Indian and Burmese species and varieties, recorded the following species from northern Siam:—

<i>P. polita</i> (Deshayes)	<i>P. gracilis</i> (Lea).
<i>P. conica</i> (Gray)	<i>P. dalyi</i> Blanford.

To these must be added the race described by Nevill long previously as *Ampullaria turbinis* var., *subampullacea*, and also a second variety of the same species (*lacustris*) to be described here, a hitherto unknown species for which I propose the name *P. angelica*, and, finally, the Cambodian species *P. begini* (Morlet). I regard *P. dalyi* as a variety of *P. turbinis*. The following list of species, varieties and localities embodies our present knowledge of the geographical distribution of Siamese forms so far as that kingdom is concerned:—

P. polita. Bangkok & Chengmai (*Fisch. & Dautz.*); ? Upper Menam (*Blanford*).

P. conica. Pitsanuloke; Lampun (*Blanford*).

P. gracilis. Lampun (*Blanford*).

P. angelica. Bangkok.

P. turbinis. "Siam".

P. turbinis race *dalyi*. N. Siam (*Blanford*); Pitsanuloke.

P. turbinis race *subampullacea*. Singgora and Patalung.

P. turbinis race *lacustris*. Inner region of Inland Sea of Singgora.

P. begini. Lat Bua Kao, Korat.

P. pesmei. Srakao (*Fisch. & Dautz.*); Koh Samesan off C. Liant.

I have examined shells of all these species, and radulae of *P. conica*, *P. angelica*, *P. turbinis* var. *subampullacea*, *P. begini* and *P. pesmei*.

KEY TO THE SIAMESE SPECIES OF PACHYLABRA

- I. Shell with $6\frac{1}{2}$ whorls.
 - A. Shell of moderate size, of very regular ovoid form, with the mouth projecting very little laterally; the surface highly polished *P. polita*.
 - B. Shell large, globose, with mouth projecting abruptly from the body-whorl; the surface not highly polished *P. angelica*
- II. Shell with $4\frac{1}{2}$ — $5\frac{1}{2}$ whorls.
 - A. Shell somewhat elongate, of rather small size, with the upper end of the mouth considerably below the upper margin of the body-whorl.
 - i. Mouth of shell more than twice as high as broad; dark spiral bands well developed *P. gracilis*.
 - ii. Mouth of shell not more than twice as high as broad; dark spiral bands obsolete or absent *P. conica*.
 - B. Shell globose, with the spire little exerted and the upper end of the mouth only a short distance below the upper margin of the body-whorl.
 - i. Adult shell at least 70 mm. high, never very thick, without a raised and thickened peristome *P. turbinis*.
 - ii. Adult shell between 50 and 60 mm. high, very thick, with a raised and thickened peristome *P. begini*.

- iii. Adult shell less than 40 mm. high,
moderately thin, without a raised and
thickened peristome *P. pesmei*.

This key can be applied only to adult shells and it must be remembered in using it that the shells of *Pachylabra* experience a short period of active growth in the rainy season, in which the peripheral part of their mouth is absorbed and the shell temporarily assumes an immature appearance. For taxonomic purposes shells are best collected towards the end of the wet season or while the animal is in a comatose condition.

Pachylabra polita (Deshayes)

1884. *Ampullaria polita*, Nevill, *Hand List Moll. Ind. Mus.* II, p. 7 (? with var. *compressus*).
1906. *Ampullaria polita*, Dautzenberg & Fischer, *Journ. de Conchyl.* liv. p.426 (? with var. *major*).
1911. *Pachylabra polita*, Kobelt, *op. cit.*, p.82, pl. xxxviii, figs. 1-5.

This is an unusually distinct and well-defined species, readily distinguished from all others by its regularly ovoid outline, in which (in ventral view) the projection of the mouth causes little interruption. The spire is of considerable relative length, occupying about $\frac{1}{3}$ of the total height, and sharply conical in form. The shell is about $1\frac{1}{4}$ - $1\frac{1}{2}$ times as high as broad. There are $6\frac{1}{2}$ whorls. The basal whorl of the spire is broad and swollen and the suture both above and below it is deeply impressed. The body-whorl is less globose than in most species. It is irregularly and narrowly cordiform, with the inner outline as seen in dorsal view very oblique and somewhat sinuate towards the anterior extremity, which is bluntly pointed. The suture is not oblique, except, in some shells, just above the body-whorl, where it is apt to change its course in such a way that the depth of the penultimate whorl becomes considerably greater in its outer than in its inner half as seen in dorsal view. The mouth is long and narrow and its main axis forms a very acute angle with that of the shell. It is pointed above and slightly introverted; below it is narrowly rounded. The lip is sharp and the callus not strongly developed. The shell is imperforate or narrowly rimate and the columellar border is slightly expanded over the

umbilicus. The outer lip at the anterior end of the mouth is very slightly expanded.

The external surface of the shell is highly polished and often has a malleated appearance due to relatively large but very shallow depressions arranged roughly in a spiral manner. Numerous minute longitudinal striae can be detected with the aid of a hand-lens.

The external colour is pale olivaceous green, sometimes with a reddish tinge. Spiral bands are absent, but irregular black longitudinal lines sometimes occur. The outer lip is sometimes blackened externally. The interior of the shell is yellowish white and the periphery of the mouth is more or less infuscated.

The operculum is thin, long and narrow, with the posterior extremity pointed and slightly introverted and the anterior extremity narrowly rounded. The outer margin is evenly convex, the inner margin rather deeply concave in its posterior half, nearly straight anteriorly. The external surface is concave as a whole, the internal surface slightly convex. There is a well defined ridge on the inner border of the former, proceeding forwards from a point a little in front of the posterior extremity and gradually growing broader until it reaches a point about two-thirds the distance from the posterior to the anterior extremity. The lines of growth are well-defined and regular and the epidermis thin and polished. The muscular scar on the internal surface is large and its smooth area relatively extensive. The sculpture of the border of the scar is minute and irregular and does not extend outwards over the whole border on the outer edge of the scar. On the inner edge the scar is defined by a prominent ridge. The nacre is of a leaden grey tint.

The following measurements are those, with the exception of the first shell, of specimens assigned by Nevill to his var. *compressa*. I have not the material to decide whether either this variety or Fischer and Dautzenberg's var. *major* is beyond the limits of individual variation.

MEASUREMENTS (IN MILLIMETRES) AND PROPORTIONS OF SHELLS.

Height	...	...	...	75	61	55
Maximum diameter	...	...	...	60	46	41

Height of mouth (oblique) ...	55	41	40
Maximum diameter of mouth ...	27	21	20
Maximum diameter to height ...	1:1.25	1:1.33	1:1.35.
Maximum diameter to height of mouth ...	1:2.03	1:1.95	1:2.
Mouth to height ...	1:1.36	1:1.49	1:1.37.
Max. diam. mouth to max. diam. ...		1:2.19	1:2.05.

These shells are all from Cambodia. Kobelt states that *P. polita* is the characteristic form of that country and of Cochin China. It is probably less common in Siam than the forms of *P. turbinis*, but has been recorded from Bangkok and Chiangmai.

Pachylabra conica (Gray).

1911. *Pachylabra conica*, Kobelt, *op. cit.*, p. 93, pl.xl, figs.1-5, 8. 9.

In some respects the shell of this species resembles that of *P. polita*, but it is usually smaller and never has the same regular ovoid shape, highly polished surface or finished appearance. The mouth projects abruptly in ventral view and the whorls are more tumid, the suture more regularly oblique. The sculpture of the surface is also different, the longitudinal striae being much coarser and more irregular, fine longitudinal ridges being often present on the body-whorl and spiral, minutely interrupted lines also occurring in large numbers. The mouth is as a rule broader and more oblique and the spire blunter.

The colour is dull olivaceous green or brown, occasionally with irregular longitudinal dark lines and usually with obsolete brownish spiral bands. The lip is very narrowly, if at all, blackened. The interior of the shell is ornamented with fairly conspicuous brownish spiral bands, which sometimes extend to the periphery of the lip, which is sometimes white.

The operculum is relatively broader and shorter than that of *P. polita*, with a rather more regular ovoid outline. The inner border of the muscular scar is sometimes rather deeply sculptured in a concentric manner, as is shown in Kobelt's figure, but this is not a constant character.

The radula closely resembles that of other species of

Pachylabra, a genus in which specific differences are not strongly marked in the teeth. Each transverse row consists of seven teeth, two marginals and one lateral on each side of an unpaired central, giving the dental formula 2. 1. 1. 1. 2. The central is transverse and about twice as broad as high. It bears at either side of its base a fairly prominent almost vertical fold and its free margin is armed with five denticulations, all of which are sharply pointed, while the central denticulation is much larger than the others and extends downwards nearly to the base of the tooth. The lateral is comparatively stout, and its free margin resembles that of the central. The marginals have their inner margin distinctly S-shaped. They each bear three long, pointed denticulations, which in the outermost tooth are subequal. The teeth are all comparatively small.

MEASUREMENTS (IN MILLIMETRES) AND PROPORTIONS
OF SHELLS.

Height	...	24	41	41	35	35	32
Maximum diameter	...	35	34	34	30	28	30
Height of mouth	...	30	30	27	24	23	26
Maximum diameter of							
mouth	...	17	15	17	14	14	14
Maximum diameter to							
height	...	1:1.2	1:1.2	1:1.2	1:1.17	1:1.25	1:1.07
Mouth to height	...	1:1.2	1:1.37	1:1.51	1:1.46	1:1.56	1:1.28
Maximum diameter to							
height of mouth	...	1:1.76	1:2	1:1.59	1:1.71	1:1.64	1:1.64
Maximum diameter of							
mouth to that of shell	...	1:2.05	1:2.44	1:2	1:2.14	1:2	1:2.28

The average proportion of maximum diameter to height of shell is, therefore, in this series 1:1.18, or considerably more than $\frac{1}{2}$; the average proportion of the height of the mouth to the height of the shell 1:1.43; that of the maximum diameter of the mouth to its height 1:1.72, considerably more than one half; that of the width of the mouth to the total width slightly less than half.

The series of shells of which these measurements are given is from Akyab in Arakan. The species is the dominant one in Lower

Burma and its range extends to China. Blanford records it from Pitsanuloke.

Pachylabra gracilis (Lea).

1856. *Ampullaria gracilis*, (Lea), *Proc. Ac. Nat. Sci. Philadelphia*, VII, p.110.

? date. *Ampullaria gracilis*, *id.*, *Obs. Genus Unio*, etc. XI, p.70, pl. xxii, fig. 1.

Lea's figure and descriptions are probably based on a young shell, and the only specimen I have seen also seems young. The adult shell may be identical with one of those figured by Kobelt (*op. cit.*, pl. xxxvii, fig. 4) as shells of *P. dalyi*; but this figure certainly does not represent either that race or any other of *P. turbinis*. The specimen I have examined resembles a young shell of *P. conica*, but is longer in proportion, with a longer and narrower mouth, a more exserted spire, a more even surface and more conspicuous external spiral bands. The lip is also more sinuous and more produced at the anterior end. The sculpture consists of fine longitudinal ridges with obsolete longitudinal and spiral striae.

The following are the measurements and proportions of this shell:— height 35, maximum diameter 29, height of mouth 25, maximum diameter of mouth 11 mm. Proportion of maximum diameter to height of shell 1:1.2, height of mouth to that of shell 1:1.4, maximum diameter to height of mouth 1:2.26, maximum diameter of mouth to that of shell 1:2.63.

This shell is labelled "Siam" and the species was described without any more precise locality. Blanford records it from Lam-pun in the northern part of the Kingdom.

Pachylabra angelica, sp. nov.

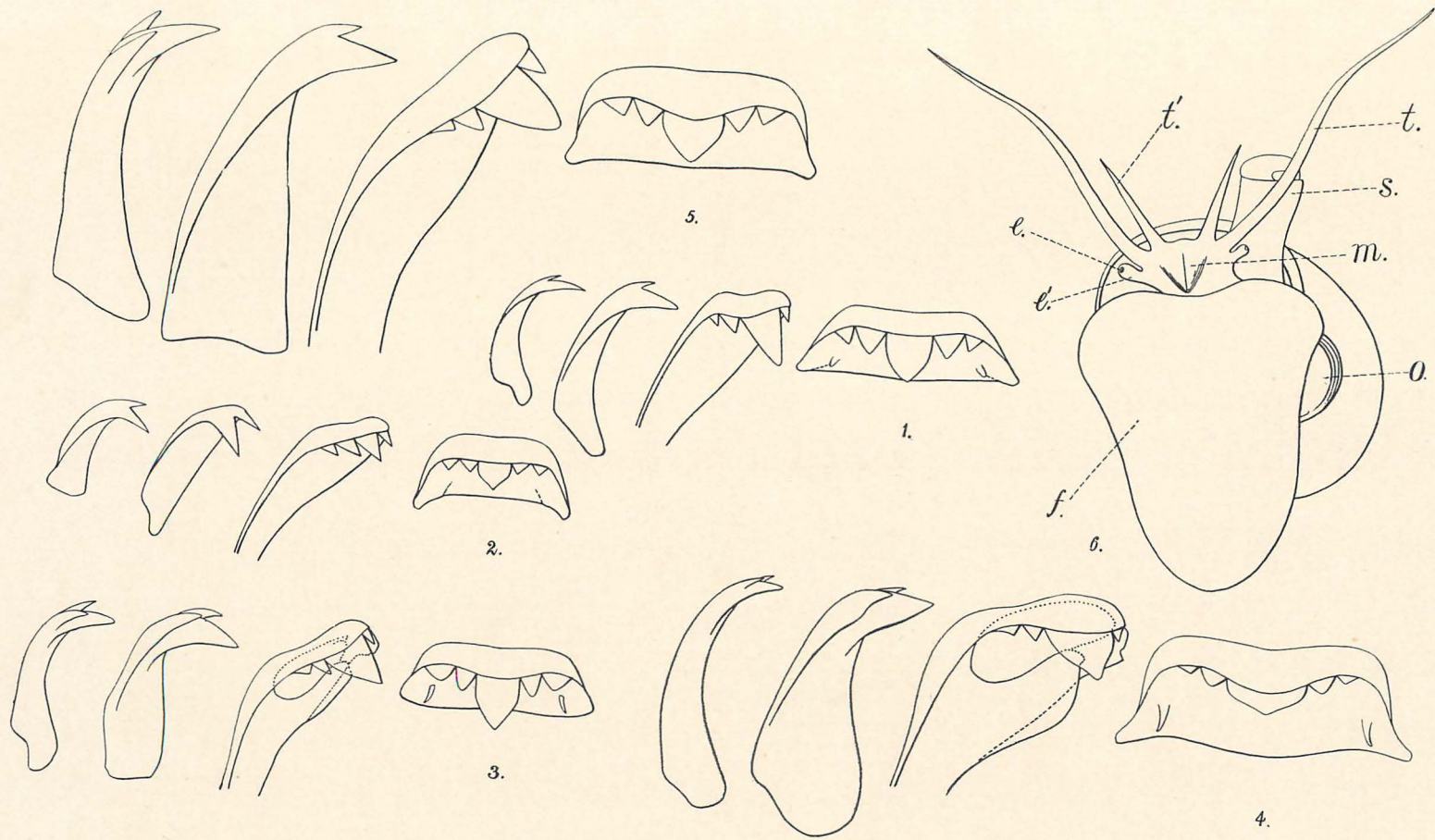
The shell is large, of moderate thickness and in shape intermediate between *P. polita* (Desh.) and *P. turbinis* (Lea); it is much more globose than the former but has a whorl more than the latter, than which also it is slightly more elongate. Its total height is a little greater than its maximum diameter. There are $6\frac{1}{2}$ whorls, and the spire, though almost acuminate, has a globose appearance towards the base, with somewhat swollen whorls. The extent to

which it is exerted differs in different individuals, but it is never so long as that of *P. polita* or *P. conica*, or so short as that of most forms of *P. turbinis*. The upper surface of all the whorls is slightly, obliquely flattened, but they are never angulate or carinate. The suture is impressed. The body-whorl is broad but oblique. The mouth of the shell is large and a little less than twice as high as broad, but the upper extremity is separated from the upper margin of the body-whorl by a distance considerably greater than the height of the spire. The main axis of the mouth forms an acute angle with that of the shell. The peristome is continuous and the callus well developed, but not prominent, in complete shells. The upper extremity of the lip is thickened at its junction with the shell and there is a rather broad thickened ridge just inside its outer margin, which is itself sharp. The lower or anterior margin is very little expanded or everted. The shell is narrowly umbilicate and the expanded callus is reflected over the umbilicus.

The external surface is not strongly polished. It is sculptured with numerous fine, low, close-set longitudinal ridges, some of which (set apart at fairly regular intervals) have a broader and flatter appearance than the others. The ridges are crossed by still more numerous minute, decussate or guttate spiral striae, and the surface has a distinctly sculptured look to the naked eye, at any rate on the body-whorl.

The external colour is uniform olivaceous, in some shells with a rather pale greenish and in others with a dark almost purplish tint. The internal surface is greenish white in pale shells and the periphery is faintly stained with pale yellow, the lip being sometimes very narrowly bordered with black. Darker shells are deep purple internally, with a faint indication of spiral bands, which are probably quite visible in young shells. Adult shells of this type have a broad white border to the lip and columella.

The operculum is thick and heavy. Its outline is irregularly pyriform, the external margin being strongly convex and the upper part of the inner margin deeply concave. The posterior extremity is bluntly pointed. The external surface is irregularly concave as a whole, and has the growth lines delicate but distinct. The



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SIAMESE AMPULLARIIDÆ.

EXPLANATION OF PLATE II.

Radular teeth of Siamese species of *Pachylabra* all x 75.

Fig. 1. *Pachylabra pesmei* (Morlet).

Fig. 2. *Pachylabra conica* (Gray).

Fig. 3. *Pachylabra begini* (Morlet).

Fig. 4. *Pachylabra turbinis* var. *subampullacea* (Nevill).

Fig. 5. *Pachylabra angelica*, sp. nov.

Fig. 6. Living animal of *P. angelica* as seen from below.

e = eye; e' = eye-stalk; f = foot; m = mouth; o = operculum; t. = tentacle; t' = oral process; s. = siphon;

1000
1000

epidermis is moderately thick and not highly polished; it is of a deep brownish colour. The naere is livid greyish stained with pink. The muscular scar is large. Its smooth area is long, narrow and prominent. The sculptured border is broad and shallow except at the outer anterior extremity, where there is a distinct pit. The sculpture of this border is obscure and shallow.

The exposed parts of the animal are of an almost uniform sooty black colour. The foot is large, narrowly cordate and bluntly pointed behind. The tentacles are long and slender and the oral processes taper distinctly to their extremity, which is filiform. The siphon is short and broad.

The jaws are stout and strongly chitinated; each has a single projection on its free edge. The radular teeth are also strongly chitinated. They have the usual formula (2. 1. 1. 1. 2.) and closely resemble those of *P. conica* except that they are larger and stouter, with broader denticulations. The central is $2\frac{1}{2}$ times as broad as high, and the latero-basal folds on its disk are very poorly developed. The distal part of the marginals is longer and stouter, and the outer denticulations of the outermost tooth is much smaller than the middle one. The most noteworthy radular character is the large size of the teeth.

MEASUREMENTS (IN MILLIMETRES) AND PROPORTIONS OF SHELLS.

Height	75	73	65
Maximum diameter	65	66	60
Height of mouth (oblique)	58	55	51
Maximum diameter of mouth	31	31	27
Maximum diameter to height	1:1.15	1:1.1	1:1.08
Maximum diameter to height of mouth	1:1.87	1:1.77	1:1.9
Mouth to total height	1:1.29	1:1.32	1:1.27
Max. diam. mouth to total max. diam.	1:2.09	1:2.12	1:2.22

The width of the shell is thus slightly less than the height,

and that of the mouth a trifle more than $\frac{1}{2}$ of its length; the height of the mouth a little less than $\frac{5}{6}$ that of the shell, and the width of the mouth just less than half of that of the shell.

Type-specimens. No. M. $\frac{11649}{2}$ Z. S. I. (*Ind. Mus.*)

This species is apparently the common one in the rice-fields round Bangkok. Dr. Malcolm Smith sent me several individuals found active in ponds in July. They arrived in Calcutta by post from Bangkok with the shell tightly closed by the operculum. They were placed in a dish of water and after about an hour the operculum gradually opened. The animal, however, remained very sluggish for the rest of the day and did not begin to feed until next morning. When they arrived the lung was evidently full of air as they floated in water. Dr. Smith tells me that the eggs are conspicuous in the rice-fields in the winter months.

I am indebted to Dr. Baini Prashad for the following particulars of the anatomy:—

"The animal of this species is on the whole of a much more massive type than of the common *P. globosa* of Bengal. The following anatomical points are interesting from a comparative point of view.

"Both the cephalic and the true pair of tentacles are long, when fully extended the true tentacles are at least two and a half times as long as the cephalic ones. Both pairs of tentacles are fairly thick at the base but taper to a point very gradually. The eye-stalks are small and thick. Both the nuchal lobes are well developed. The right lobe, though not forming an actual siphon as in *Vivipara*, forms a fairly deep groove. The left, or the respiratory siphon of the family, forms a comparatively broad and thick respiratory tube, slightly different in size and proportions from that of *P. globosa* but much more so when compared with that of *Ampullaria insularum* d'Orbigny, as figured by Fischer and Bouvier.¹ The margin of the mantle is very thick. The osphradium is large, and owing to the large development of tissue at its base may be described as pedunculate. The lung is a copious structure with a

¹ *Journ. de Conchyl.* XL, pl. iii, fig. 15.

large broad opening. The lamellae of the gills also are well developed leaf-like structures. The ridge separating the branchial from the lung portion of the respiratory cavity is particularly thick in its anterior portion. The rectum is a very thick tube and the opening of the anus is large. The sacs for the copulatory organs are well developed.

"The buccal mass is a massive structure with well developed salivary glands lying just posterior to it; the glands of the two sides are unequal, that of the right side is larger than that of the left, and is placed a little in front of it. The mouth is a large vertical opening with thick lips on its two sides. The jaws are large with a single cutting tooth developed on each. The radula and the cartilaginous flaps on its sides are both brownish in colour. The stomach has a small caecum.

"There is nothing special to note regarding the vascular and the excretory systems. The ovary is large and cut up into a number of lobes. The albumen gland also is a large structure. The male organs are similar to those of *P. globosa*,"

Pachylabra turbinis (Lea).

- 1856. *Ampullaria turbinis*, Lea, *Proc. Ac. Nat. Sci. Philadelphia* VII, p. 110.
- 1860. *Ampullaria celebensis*, v. Martens (*nec* Quoy & Gaimard), *Proc. Zool. Soc. London*, p. 12.
- 1863. *Ampullaria turbinis*, Morelet, *Ser. Conchyl.* III, p. 288.
- ? date *Ampullaria turbinis*, Lea, *Obs. Genus Unio*, etc., XI, p. 70, pl. xxii, fig. 2.
- 1884. *Ampullaria turbinis* and var. *subglobosa*, Nevill, *Hand List Moll. Ind. Mus.* II, p. 6.
- 1904. *Ampullaria turbinis*, Fischer & Dautzenberg, *Et. div. Miss. Pavie Indo-Chine* III, p. 425.
- 1905. *Ampullaria turbinis* and var. *erythrocheila*, Dautzenberg & Fischer, *Journ. de Conchyl.* LIII, p. 427.
- 1911. *Pachylabra turbinis*, Kobelt (in part), *op. cit.*, *supra*, p. 78, pl. xxxvii, fig. 3.

Lea's English description of the species, which seems to be the dominant one in Siam, is as follows:—

"Shell turbinate, yellowish green, transversely banded, rather thick, scarcely perforate, smooth; spire very much depressed: sutures slightly impressed; whorls about five, very convex;

aperture very large, elongately ovate, brownish and much banded within; outer lip acute; columella very much incurved and thickened".

"Diam. 2.36, Length 2.46 inches".

Several local races are found in different parts of Siam and the adjacent countries and it is improbable that all the references given above refer to the *forma typica*. It will be well, therefore, to give a new description of this form.

The shell is large, globose, of moderate thickness. There are $4\frac{1}{2}$ whorls but the apex is often eaten away. The total height is the same as, or practically the same as, the maximum diameter. The spire is depressed and flattened at the base. It projects very little, but is somewhat variable in its exact proportions. The upper surface of all the whorls is slightly flattened, but they are never angulate or carinate. The suture is moderately impressed. The body-whorl is very broad and not very oblique. The mouth of the shell is large and nearly or quite twice as high as broad. Its upper extremity is separated from that of the body-whorl by a distance distinctly greater than the length of the spire. The umbilicus is very narrow and is more or less completely concealed by the expanded columellar callus. In shells that have finished their growth-period the callus is well developed and thick but not prominent. There is a low, narrow rather indistinct thickening of the shell inside the lip, which is sharp. This thickening is most strongly developed in the upper angle. The lower extremity of the mouth is very little everted.

The surface of the shell has a smooth and polished but not brilliant appearance. The sculpture is much like that of *P. angelica* but more irregular and with the thicker longitudinal ridges coarser and the transverse striae less well developed.

The colouration of the shell is variable. Young specimens are spirally banded and the bands may persist to some extent in the adult or subadult. One of the shells assigned by Nevill to his var. *subglobosa* has traces of them. In fully adult shells there are narrow longitudinal dark lines, sometimes set at very regular intervals.

MEASUREMENTS (IN MILLIMETRES) AND PROPORTIONS OF SHELLS.

Height	70	66	61
Maximum diameter	70	65	57
Height of mouth	57	54	51
Maximum diameter of mouth	31	27	26
Maximum diameter to height	1:1	1:1	1:1.07
Maximum diameter to height of mouth	1:1.84	1:2	1:1.96
Mouth to height	1:1.22	1:1.22	1:1.2
Max. diam. of mouth to maximum diameter	1:2.22	1:2.41	1:2.19

The height and the maximum diameter of the shell are thus practically the same, the mouth nearly twice as high as broad and rather more than $\frac{1}{3}$ as high as the whole shell, which is from $2\frac{1}{3}$ to $2\frac{2}{3}$ as broad as it is high.

There is no information available as to the precise habitat of this race. Lea merely says "Siam," and Nevill's specimens, with one exception, appear to have been originally labelled "Java", but he was probably right in believing that they were of Siamese origin. There is a young shell from Cambodia in the collection of the Indian Museum, but whether it belongs to this race is uncertain. It is considerably broader in proportion than young shells of the race *subampullacea*.

RACE *dalyi* (Blanford).

1902. *Ampullaria dalyi*, Blanford, *Proc. Malac. Soc. London*, V, p. 281, pl. viii, fig. 1.
 1911. *Pachylabra dalyi*, Kobelt (in part), *op. cit.*, *supra*, p.80, pl. xxxix, fig 1.
 1911. *Pachylabra turbinis*, *id.*, *ibid.*, pl. xxxvii, figs.1,2.

I think that Blanford was right in suggesting that this was only a race of *P. turbinis*. The shell is distinguished by its coarser, thicker, still more globose character and larger maximum size. The upper part of the mouth projects less in ventral view, but its maximum diameter is greater, and the base of the body-whorl is channelled just below the body-whorl. The shape of the spire varies considerably. In some specimens it is considerably more

globose than in the *forma typica*, but in others it is not so, while in one shell it is actually depressed as a whole and its suture is deeply and broadly canalized.

The surface of the shell is dull and the sculpture is coarser and at the same time more regular than that of the typical *P. turbinis*, though similar in general character.

The colour is olivaceous brown externally with fairly regular curved longitudinal dark lines. The interior of the shell is uniform white in the specimens I have examined, but these are all "dead".

The operculum is thick and heavy in these specimens and incrassated somewhat at the two extremities. The scar is large and its smooth area extensive; the sculptured border of fairly uniform width, rather shallow and irregularly and by no means deeply sculptured.

MEASUREMENTS (IN MILLIMETRES) AND PROPORTIONS OF SHELLS.

Height	...	...	89	74	67
Maximum diameter	...	...	81	62	63
Height of mouth	...	...	62	55	52
Maximum diameter of mouth...	...	...	38	31	28
Maximum diameter to height...	...	...	1:1.1	1:1.19	1:1.06
Maximum diameter to height of mouth	...	...	1:1.63	1:1.77	1:1.86
Height of mouth to height...	...	...	1:1.46	1:1.34	1:1.29
Maximum diameter of mouth to maximum diameter	...	...	1:2.13	1:2	1:2.25

This race was described from Northern Siam. The series I have examined is from Pitsanuloke.

RACE *subampullacea* Nevill.

1884. *Ampullaria turbinis* var. *subampullacea*, Nevill, *op cit.*, *supra*, p. 6.

1891. *Ampullaria turbinis* var. *subampullacea*, Möllendorf, *Proc. Zoo. Soc. London*, p. 346.

This race has the shell higher and less transverse, with the mouth higher narrower and more oblique, and the spire more prominent and pointed than the typical form. There are $5\frac{1}{2}$ whorls. The shell is not so thick and globose as in the race *dalyi* but rather

thicker than that of the *forma typica*. The spiral bands are less obsolete, especially on the internal surface, than in either, the lip is paler in colour than in the latter and there is a more definite thickening just inside its margin.

The operculum is rather thin and the smooth area of the scar is relatively large.

The radula is normal. The teeth are large. The central tooth is rather more than $2\frac{1}{2}$ times as broad as high. Its lower angles are produced and sharp, the folds on its disk triangular and prominent; the central denticulation does not reach the base of the tooth and has only two well-developed smaller denticulations on each side. The other teeth are broad at the base. The lateral has the central denticulation as broad at the base as long and two small denticulations at either side. The denticulations of the marginals are long, sharp and unequal.

MEASUREMENTS (IN MILLIMETRES) AND PROPORTIONS OF SHELLS.

Height	...	...	76	73	81	73
Maximum diameter	...	...	70	70	77	70
Height of mouth	...	...	61	58	64	61
Maximum diameter of mouth	...	...	30	30	31	31
Maximum diameter to height	...	...	1:1.08	1:1.04	1:1.05	1:1.04
Maximum diameter to height of mouth	...	...	1:2.03	1:1.93	1:2.06	1:1.97
Mouth to height	...	...	1:1.24	1:1.26	1:1.26	1:1.2
Maximum diameter of mouth to maximum diameter	...	...	1:2.33	1:2.33	1:2.61	1:2.35

The height is thus slightly greater than the maximum diameter, the height of the mouth about twice its maximum diameter. The height of the shell is about $1\frac{1}{4}$ the height of the mouth and its maximum diameter $1\frac{1}{3}$ to a little over $1\frac{1}{2}$ the maximum diameter of the mouth.

Type-specimen. No. 2427 M (Z. S. I.).

This is evidently the Malayan race of the species, but its range extends northwards into Peninsular Siam. It was originally described from Perak, is stated by Möllendorf to be common in the Malay

Peninsula, and is the form found in ponds and sluggish streams in the province of Singgora.

The eggs are laid about Christmas or the beginning of the year, as soon as the rains cease. They are exposed some feet above the surface of the water on tree-trunks, posts or the stems of reeds, and are formed into oval masses about the size of a small hen's egg. As they are of a pure white colour they are very conspicuous. The individual eggs are about 6 mm. in diameter but are pressed so closely together that they are usually distorted. Only those in the centre of the mass are fertile or contain yolk, those that cover it externally being reduced to dry scale-like bodies, which protect the true eggs. The scale-like aborted eggs are absent from the base of the mass where it is in contact with the surface to which it is attached. In spite of the protection thus afforded, the fertile eggs are sometimes parasitized by a small wasp. The var. *lacustris* has the same habits of oviposition and often attaches its egg-masses to limestone cliffs. Whether other Siamese species or varieties produce egg-masses of the same type I do not know. In the common Indian *P. globosa* and *P. carinata* the eggs are laid in a shallow depression in damp ground at the edge of water. They form a feebly coherent mass and are all normally constituted and of a spherical shape. In Bengal the eggs are laid after the rains break, about July; but in Madras I have found them rather later in the year.

RACE *lacustris*, nov.

I propose this name for a form found at the edge of the inner or freshwater region of the Tale Sap or Inland Sea of Singgora. The spire is still smaller (and flat at the apex) and the body-whorl still broader and more oblique than in shells of the var. *subampullacea* from the same district. The surface is also more irregular and more frequently eaten away. The colour of the shell is also as a rule darker and rougher, but this may be due to the more frequent growth of minute algae on the surface.

MEASUREMENTS (IN MILLIMETRES) AND PROPORTIONS OF SHELLS.

Height	...	78	75	67
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Maximum diameter	...	74	73	65
Height of mouth	...	64	65	57
Maximum diameter of mouth		32	32	30
Maximum diameter to height		1:1.04	1:1.03	1:1.03
Maximum diameter to				
height of mouth		1:2	1:2	1:1.19
Mouth to height	...	1:1.22	1:1.12	1:1.17
Max. diam. of mouth to max. diam.		1:2.31	1:2.28	1:2.7

By actual measurement, therefore, the shell does not differ materially from that of the var. *subampullacea*, but it is outlines rather than actual measurements that are of importance.

Type-specimen No. $\frac{11571}{2}$ M. (Z.S.I.)

***Pachylabra begini* (Morlet).**

1889. *Ampullaria begini*, Morlet, *Journ. de Conchyl.* XXXVII, p. 184, pl. viii, fig. 1.

1901. *Ampullaria begini*, Pilsbry, *Proc. Ac. Nat. Sci. Philadelphia*, III, p. 189.

1904. *Ampullaria begini*, Morlet, *Et. div. Miss. Parie Indo-Chine*, III, p. 369, pl. xx, fig. 2.

1911. *Pachylabra begini*, Kobelt, *op. cit.*, *supra*, p. 87, pl. xxxv, fig. 4.

Though closely allied to *P. turbinis*, this species is smaller, has a thicker shell and is readily distinguished by the structure of its mouth. The umbilicus is also more open. The peculiarity of the mouth of the shell is due to the great development and prominent character of the peristome produced by the thickening and prominence of the columellar callus and border and the thickening of the lip just inside its margin. The lip is somewhat produced and everted at its lower extremity.

The surface of the shell is rather coarsely sculptured, but varies in this respect. In old shells it has, even to the naked eye, a reticulate appearance, at any rate on the body-whorl, owing to the intersection of blunt longitudinal and spiral ridges. The latter are particularly well developed. Minute spiral striae also occur, but are often hard to detect. The shell seems to be peculiarly liable to erosion both of the spire and of the body-whorl.

The colour varies. In one fresh shell from the Korat district

it is pale fulvous with a pinkish tinge and blotched with white; but this shell appears to be diseased, though the animal in it seems to have been quite healthy. Morlet's description gives the colour as greenish yellow with several obscure spiral bands; the mouth of a brownish tint with several bands inside; the columellar margin yellowish. Most of the shells I have seen are blackish or olivaceous brown, sometimes with indistinct darker spiral bands. These shells have the peristome reddish and the interior of a dull purple tint.

The operculum is moderately thick and is less asymmetrical than that of some species. The posterior extremity is blunt. Both extremities are somewhat thickened. The external surface is only slightly concave. The smooth area of the scar is narrow and the sculptured border broad and shallow, except at the anterior extremity, where it is rather deeply hollowed. The sculpture is obscure and irregular.

The radula is characterized by the breadth of the larger denticulations of the teeth. The central is three times as broad as deep and its central denticulation does not quite reach its base. The latero-basal folds are well-developed, narrow and pointed, the lateral denticulations ill-defined. In the lateral tooth only one lateral denticulation can be distinguished on each side, while in the marginals the outer denticulation is relatively small.

MEASUREMENTS (IN MILLEMETRES) AND PROPORTIONS OF SHELLS.

Height	...	...	...	48	45	41	30
Maximum diameter	...	...	...	50	40	36	27
Height of mouth	...	...	...	35	33	32	23
Maximum diameter of mouth	...	...	...	20	18.5	16	12.5
Maximum diameter to height	...	...	...	1:0.96	1:1.12	1:1.14	1:1.11
Maximum diameter to height of mouth	...	...	...	1:1.75	1:1.8	1:2	1:2.16
Mouth to height	...	...	...	1:1.37	1:1.36	1:1.28	1:1.3
Maximum diameter of mouth to maximum diameter	...	...	...	1:2.5	1:2.16	1:2.25	1:2.16

The shell is a little higher than broad and its mouth is

from $1\frac{3}{4}$ to twice as high as broad. The total height is from $1\frac{1}{4}$ to $1\frac{2}{5}$ that of the mouth and the maximum diameter is about twice that of the mouth.

The species is said to be common on the lower Mekong and in Cambodia. Mr. Boden Kloss found it abundant in rice-fields at Lat Bua Kao near Korat.

Pachylabra pesmei (Morlet).

1889. *Ampullaria pesmei*, Morlet, *op. cit.*, p.185 pl. viii, fig.2.

1904. *Ampullaria pesmei*, *id.*, *op. cit.*, p.369, pl. xx, fig. 12.

1911. *Pachylabra pesmei*, Kobelt, *op. cit.*, p.88, pl. xxxv, fig. 8.

P. pesmei is one of the smallest species in the genus. It has a thinner shell than *P. begini*, to which it is closely related, and the peristome, though complete, has not the same prominent character. The umbilicus also is much narrower. The colour of the shell varies. In Morlet's type it had a curious bluish pink tinge. In the shells I have seen it is rather pale olivaceous brown with or without rather faint spiral bands externally. The interior of the shell is yellowish with a tinge of purple and marked with dark purple spiral bands, which are sometimes confluent and become more conspicuous on the interior of the lip. The peristome is yellowish. The external surface has a rather high polish and the sculpture resembles that of the shell of *P. begini* but is finer.

The operculum is thinner and more pointed posteriorly than that of *P. begini*, and the sculpture of the border of the scar has on the inner margin of the smooth area a concentric arrangement.

The radular teeth are relatively large. The central is more than three times as broad as high and the cusps of all the teeth are narrower in proportion than in *P. begini*.

MEASUREMENTS (IN MILLIMETRES) AND PROPORTIONS OF SHELLS.

Height	32	30	31	32	31
Maximum diameter	30	27	28	29	28
Height of mouth	24	21	23.5	23	23
Maximum diameter of					
mouth	15	12	11	13	12

